ATMOSPHERIC ELECTRICITY.

AURORAS.

The auroral display of the 27th was very brilliant and was seen at numerous points from Maine to Dakota, and as far south as Nashville, Tennessee, and Fort Sill, Indian Territory.

The following reports relate to this display:

Mount Washington, New Hampshire: at 9.10 p. m., although the sky was overcast, a bright light was noticed near the northeastern horizon and an auroral display was suspected. At 9.45 p. m. the fog lifted and a very extensive aurora could be seen through rifts in the clouds, which at 10.25 p. m. entirely disappeared, disclosing to view a very brilliant aurora. Waves of light, parallel with the horizon, rose from every point of the compass except from the southeast and southwest. The auroral light nearly covered the sky and was without color with the exception of the waves rising from the north which were of a greenish tint. The maximum brilliancy occurred at 11.15 p. m., after which it gradually subsided and disappeared at 1.45 a. m. of the 28th.

Boston, Massachusetts: an aurora became visible soon after dark on the evening of the 27th. It first appeared as streamers having an altitude of 60° and azimuth of 70°. The aurora gradually changed its form and appeared as two arches, one above the other, with a dark segment between; the altitude of the upper arch was 55°, azimuth, 80°; altitude of the lower, 20°, azimuth 30°, at the same time streamers shot up from both arches, occasionally flashing out with great brilliancy. At 10 p. m. the arches had disappeared, their places being taken by streamers which at times extended 10° beyond the zenith. The light began to decrease after midnight and ceased altogether about 3 a. m. of the 28th. The centre of the display was almost due north. The greatest brilliancy occurred between 11 p. m. and midnight. During the display telegraph and telephone wires worked badly, the same difficulty was also experienced during the afternoon, indicating the presence of the aurora at that time.

Menand's Station, Albany county, New York: on the 27th an aurora was observed from 8.30 to 11.15 p. m. When first noticed it displayed a small arch from which broad beams of light shot upward to an altitude of 45°. At 10.30 p. m. these beams had increased in size and brilliancy, extending nearly to the zenith, through which an arch spanned the entire sky.

Philadelphia, Pennsylvania: an aurora was observed at 10.48 p. m. of the 27th, At the time when the aurora was first observed a bank of clouds, about 30° in altitude, filled the northern sky. Above the clouds was a pale yellowish light from which rose slender waving beams to an altitude of 75° and having a motion from north to west. The aurora disappeared at 11.20 p. m.

Albany, New York: an auroral display was observed from 8.50 to 11.45 p. m. of the 27th. The aurora extended from 100° to 180° azimuth and to an altitude of 45°, and consisted of a luminous arch, from which streamers rose toward the zenith. At 10 p. m. the display became very brilliant and long streamers, of the variety known as the "merry dancers," shot up beyond the zenith.

Shelter Island, Long Island, New York: At 8.13 p. m. of the 27th a low, narrow arch of light, about 15° broad, was seen in the northern sky. At 9.40 p. m. the upper part of the arch had extended beyond the zenith, and at intervals of three or four minutes very bright streamers shot out from the lower, as well as the upper, side of the arch. At 11.30 p. m. the aurora was seen low in the north as an arch of golden light.

New London, Connecticut: on the 27th an aurora began about 7.45 p. m., in the form of a diffuse light of pale straw color, in the northern sky. The aurora was about 45° in altitude and 90° azimuth. At 11 p. m. the display was very brilliant, numerous streamers of varying heights being visible, some reaching nearly to the zenith. At midnight the streamers had disappeared, but the auroral light continued until dawn of the 28th.

Parkersburg, West Virginia: on the 27th a brilliant aurora commenced at 8.45 p. m. and continued until 12.30 a. m. of the 28th. An arch extended from west to northwest; from the arch, streamers reached to the zenith.

Toledo, Ohio: at 9.30 p. m. of the 27th a single band of white light was seen extending from 150° to 240° azimuth, and from 20° to 27° altitude. These conditions continued until 10.55 p. m., when the lower edge descended to within 10° of the horizon, while streamers shot up to an altitude of 60° and 70°, the color also changed to a rosy tint. The display ceased at 11.20 p. m.

Columbus, Ohio, 27th: an auroral arch appeared at 8 p. m. in the north. At 8.15 p. m. bright streamers began to shoot up from the arch, some of them extending to near the zenith, after which they began to fade, the aurora disappearing at 9.50 p. m.

Yellow Springs, Greene county, Ohio: about 8 p. m. of the 27th a white band of light appeared in the west, and extended about 30° across the sky in an east-northeasterly direction. Shortly after the light disappeared, and reappeared again at 9.30 p. m., when an arch of white color appeared stretching from northwest to northeast. The highest point was about 8° above the horizon. About 9.45 p. m. beams of light flashed up above the arch and extended half way to the zenith. The arch gradually rose several degrees; about fifteen minutes after the first appearance of beams the aurora had disappeared.

Sandusky, Ohio: at 10.20 p. m. of the 27th an auroral light was seen bordering a dark cloud which extended from azimuth 135° to 225°, and to an altitude of 15°. The light was stationary until 11 p. m., when a quivering motion was seen and a few streamers arose from behind the cloud, this continued until 11.30 p. m., after which the aurora gradually faded and had disappeared at midnight.

Des Moines, Iowa: at 11.15 p. m. of the 27th a bright auroral arch was seen, extending from the northwestern to the northeastern horizon and rising to an altitude of 20°; pale streamers extended from the arch to an altitude of 50° and 60°. The display reached its maximum brilliancy at 11.30 p. m., and disappeared at 11.55 p. m.

Huron, Dakota: a very brilliant aurora was seen from 10.40 p. m. of the 27th until after midnight. The aurora appeared as an arch extending from a little west of north to about 10° south of east, from the arch quivering streamers rose to various heights.

Saint Paul, Minnesota: on the 27th, from 10.10 to 11.45 p. m., a pale yellow auroral light was observed through rents in the clouds along the northern sky. The extent of the display could not be traced, owing to the clouds which nearly covered the sky, but a faint yellow glow could occasionally be seen as high as 60°.

Moorhead, Minnesota, 27th: at 10.4 p. m. faint streams of light extending upward toward the zenith became visible in the east; shortly after other streams appeared in the west, and, joining with the former, formed a band of light, extending from the east through the zenith to the west. From the north waves of light began to move in rapid succession toward the zenith. The display continued until midnight.

Bismarck, Dakota: on the 27th, at 10.50 p. m., a brilliant aurora was seen extending from azimuth 140° to 202° and to an altitude of 65°. Its maximum brilliancy occurred at 11.15 p. m., when the light appeared as sinuous bands, having a waving motion from east to west. At 11.50 p. m. the light appeared in the form of a perfect arch, resting upon a dark segment 10° in altitude. The display disappeared at 3 a. m. of the 28th.

Fort Assinaboine, Montana: on the 27th a bright aurora was seen from 11.07 p. m. until after midnight. The aurora consisted of an arch of bluish white color, resting on a dark segment; the arch was from 25° to 28° in altitude, and extended from 80° to 320° azimuth. Motionless streamers reached almost to the zenith; they disappeared at 11.50 p. m. and the arch at 12.15 a. m. of the 28th, and was replaced by a low, dark cloud.

Webster, Day county, Dakota: a fine auroral display was

observed from 9.30 p. m. of the 27th until midnight. The aurora extended from east to west and covered more than half of the sky. At 10.30 p. m. an arch of light, spanning the sky from east to west, was formed in the south, about 30° from the zenith.

Pike's Peak, Colorado: an auroral light was observed in the northeast at 10.20 p. m. of the 27th. At 10.45 p. m. streamers could be distinguished between the clouds that partially obscured the sky. The aurora disappeared at 11 p. m.

Clayton, Jefferson county, New York: Prof. G. K. Gilbert, of the Geological Survey, who observed the aurora of the 27th from this place, says:

I seemed to be looking up into a system of discontinuous curtains, with cross-sections, the most southerly being high, hazy, and cloudlike.

Saint Vincent, Minnesota: at 11.18 p. m. of the 3d an auroral light was seen traversing the sky from east to west through the zenith. This formation continued until a heavy bank of cumulo-stratus clouds which rested on the northern horizon had disappeared, when the arch faded and the auroral light began shooting up from the north in the form of streamers. The aurora disappeared at 2.00 a. m. of the 4th.

Auroral displays were also observed during the month, as follows:

1st.—Eastport, Maine.

2d.—Fort Totten, Dakota; West Union, Iowa; Escanaba, Michigan; Moorhead, Minnesota; Mount Washington, New Hampshire; Syracuse, New York.

3d.—Mount Washington, New Hampshire.

4th.—Webster, Dakota.

5th.—Pekin, Illinois.

7th.—Fort Brady, Michigan.

8th.—Pekin, Illinois.

12th.—Post Mills, Vermont; Tatoosh Island, Washington Territory.

16th.—Wellsborough, Pennsylvania.

19th.—Mackinaw City, Michigan.

20th.—Fort Totten, Dakota.

22d.—Webster, Dakota; Gardiner, Cornish, and Kent's Hill, Maine; Traverse City and Mackinaw City, Michigan; Moorhead, Minnesota; Berlin Mills, New Hampshire; Albany, New York.

23d.—Webster, Dakota.

25th.—Central College, Missouri; West Milton, Ohio.

26th.—Cedar Rapids, Iowa; Wellsborough, Pennsylvania; Burlington, Vermont.

27th.—New Haven, North Colebrook, Southington, and Voluntown, Connecticut; Fort Buford, Fort Totten, and Yankton, Dakota; Riley and Windsor, Illinois; Indianapolis, Indiana; Fort Sill, Indian Territory; Keokuk, Cedar Rapids, Bancroft, Clinton, and Corydon, Iowa; Yates Centre and Salina, Kansas; Portland and Gardiner, Maine; Woodstock, Maryland; Milton, Somerset, Provincetown, Westborough, Fall River, Princeton, Taunton, Deerfield, Cambridge, Quincy, and Amherst, Massachusetts; Grand Haven, Mackinaw City, and Alpena, Michigan; Saint Paul, Minnesota; Central College, Missouri; Valentine, Marquette, and Genoa, Nebraska; Nashua, New Hampshire; Atlantic City, Clayton, and Egg Harbor City, New Jersey; Oswego, Rochester, Cooperstown, North Volney, Factoryville, Menand's Station, Mountainville, Ithaca, Palmyra, and Setauket, New York; Wauseon, Garrettsville, and Elyria, Ohio; Erie, Dyberry, Grampian Hills, and East Brook, Pennsylvania; Block Island, Rhode Island; Nashville, Tennessee; Lunenburg, Newport, Strafford, and Poultney, Vermont; Lynchburg and Wytheville, Virginia; Delavan, Wisconsin.

28th.—Milton, Heath, and Quincy, Massachusetts; Central College, Missouri; Rochester, New York; Fort Spokane, Washington Territory; and Fort Bridger, Wyoming.

THUNDER-STORMS OF JULY, 1886.

[By Jr. Prof. H. A. HAZEN.]

There have been received during July 699 reports of distinct storms from voluntary observers, 355 from Signal Service observers, and 1,654 from special thunder-storm observers, making a total of 2,708. The distribution according to states and districts will be seen from the accompanying table. There have also been a large number of storms noted in the more southerly states, but these do not usually occur under the same conditions as do those further north, and as special observers have been obtained in the Northern States only, those from the southerly states have not been combined in this table. As there are nearly twenty times more special observers in Ohio than in any other state, this will account for the relatively larger number there. The days of greatest frequency were the 13th, 14th, 17th, 26th, and 31st, and those of least frequency the 1st, 2d, 4th, 5th, 6th, and 24th.

The accompanying chart, viii, is presented as giving a view of conditions of pressure, temperature, and wind-direction on the 14th, which may be regarded as a typical case. Lines of equal pressure are drawn full, and those of temperature dotted. The number of storms in each state is given by figures very near the centre. It will be noted that very few of the storms lie to the west of the region marked LOW, but most of them are to the southeast and east of that region. This may be regarded as the normal condition of occurrence of thunder-storms.

On this date there developed thunder-storms of great energy in the Shenandoah Valley, accompanied by high wind, very heavy rain, and in some places hail which was very destructive to crops. A special investigation of these storms has been made, over 640 reports having been received from counties in the Shenandoah Valley and in Maryland. These reports show a fairly uniform motion from southwest to northeast. The storms were noted in the southern edge of Augusta county, Virginia, at eleven hours, and passed off the north edge of Carroll county, Maryland at fifteen hours, which gives a velocity of about forty-four miles per hour. The low area had a velocity less than half that of the storms, this singular fact has been often noted before. The storm was by no means one continuous storm, but the one just described seemed to be the principal storm in a general electrical disturbance extending over Virginia and Maryland, and probably, with less activity, over all the Eastern States. This disturbance gave rise to numerous minor thunder-storms which can be traced as having generally uniform paths in a northeast direction, but which lose their identity much more quickly than the principal storm or series of storms in the centre. Just what relation these sub-storms had to the principal one is a matter of great interest, but it cannot be settled with the present records.

A most careful record was made of the storm at Washington City. First rumblings of thunder were heard soon after noon, but no lightning till 15h.6 when there was a very sharp flash, followed by thunder, which was 2,000 feet to the southeast. A half minute later another crash of thunder was noted four miles away. At 15h.7 a clap was noted about one mile away. At 15.8 the clap was one mile and very nearly overhead. At 15.9 there was another two miles overhead. At 15.10 it was three miles off. The thunder gradually died away after 15.10. The singular fact about this storm was that it seemed to form overhead or slightly to the southeast, there being no definite movement of the storm from southwest or away from the station.

During the summer of 1885 the New England Meteorological Society began collecting detailed records of thunder-storms in New England. A report of the first season's work has been published in the "Proceedings of the American Academy," and the following extract of the conclusions of Professor Davis are taken from that:

While summer storms are much more frequent than winter storms, still they are not uniformly distributed through the season; they appear in greater number and size for a few days, and then are almost or quite absent for a time. The cause of this seems to be found in their dependence on the larger disturbances know as "areas of pressure," as used in the Signal Service publications. It may be concluded that the development of such storms depends, not only on the heat of the summer afternoons, but also on the equilibrium of the atmosphere, as determined by the circulation of cyclonic winds. This fact